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INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference HISHE-57796	FOR FURTHER ACTION see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. PCT/US 01/ 19983	International filing date (day/month/year) 22/06/2001	(Earliest) Priority Date (day/month/year) 23/06/2000
Applicant HI-SHEAR CORPORATION et al.		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

1. Basis of the report

- a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

- b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

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2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☐ the text is approved as submitted by the applicant.

☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1
☐ None of the figures.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 01/19983

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

A swage collar (3) and an internal sealing insert (5) form a swage collar assembly used in combination with a structural fastener to prevent leakage through a connection of workpieces fastened together by the structural fastener. The swage collar (3) has a hollow, generally cylindrical main body portion (1) with a main central bore (2), and a base portion (4) with an internal shoulder (6) formed in the main central bore (2) so as to form a seal receiving guide. The shaft (8) of the fastener typically includes a threaded section and an unthreaded section, and the internal sealing insert interfaces with the threaded section and the unthreaded section of the shaft of the pin. In an alternate embodiment, the internal sealing insert interfaces with the unthreaded section of shaft of the pin. The swage collar assembly is fitted over the fastener, a swaging tool is fitted over the swage collar assembly, and the swaging tool is forced over the swage collar assembly with sufficient force to cause plastic deformation in the swaging collar to force the swaging collar and internal sealing insert into engagement with the shaft of the fastener.

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/19983

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F16B19/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F16B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A ✓	US 3 094 017 A (GEORGE SIEBOL ET AL) 18 June 1963 (1963-06-18) abstract column 1, line 34 - line 49 column 3, line 23 - line 38 figures 5,9,10 ---	1-7, 12-20, 26-31
A ✓	US 5 562 379 A (RAUSCH JAMES G ET AL) 8 October 1996 (1996-10-08) abstract figures 4,6,7 --- -/--	1-4, 10-17, 26-28



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *E* earlier document but published on or after the international filing date
- *L* document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
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T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

8 document member of the same patent family

Date of the actual completion of the international search

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Name and mailing address of the ISA

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INTERNATIONAL SEARCH REPORT

International Application No

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A ✓	GB 2 119 467 A (HI SHEAR CORP) 16 November 1983 (1983-11-16) abstract figure 1	1-4, 10-17, 26-28
A ✓	US 3 464 472 A (REYNOLDS PERRY J) 2 September 1969 (1969-09-02) column 1, line 28 - line 60	1,13,21, 26,35

INTERNATIONAL SEARCH REPORT

Information on patent family members

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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
US 3094017	A	18-06-1963	NONE	
US 5562379	A	08-10-1996	NONE	
GB 2119467	A	16-11-1983	DE 3215152 A1 FR 2525704 A1	27-10-1983 28-10-1983
US 3464472	A	02-09-1969	DE 1750305 A1 ES 352931 A1 FR 1561699 A GB 1179655 A SE 352415 B	10-05-1972 16-08-1969 28-03-1969 28-01-1970 27-12-1972

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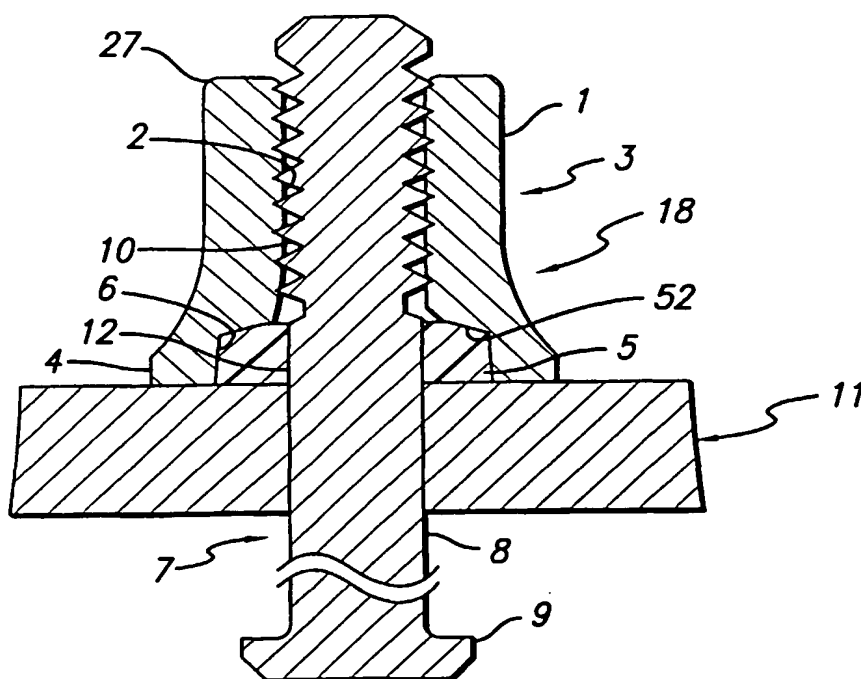
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(54) Title: SWAGE COLLAR WITH INTERNAL SEALING INSERT



(57) Abstract: A swage collar (3) and an internal sealing insert (5) form a swage collar assembly used in combination with a structural fastener to prevent leakage through a connection of workpieces fastened together by the structural fastener. The swage collar (3) has a hollow, generally cylindrical main body portion (1) with a main central bore (2), and a base portion (4) with an internal shoulder (6) formed in the main central bore (2) so as to form a seal receiving guide. The shaft (8) of the fastener typically includes a threaded section and an unthreaded section, and the internal sealing insert interfaces with the threaded section and the unthreaded section of the shaft of the pin. In an alternate embodiment, the internal sealing insert interfaces with the unthreaded section of shaft of the pin. The swage collar assembly is

fitted over the fastener, a swaging tool is fitted over the swage collar assembly, and the swaging tool is forced over the swage collar assembly with sufficient force to cause plastic deformation in the swaging collar to force the swaging collar and internal sealing insert into engagement with the shaft of the fastener.

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IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

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SWAGE COLLAR WITH INTERNAL SEALING INSERT

Related Applications:

This application is based upon provisional application Serial No. 60/213,769 filed June 23, 2000.

5

BACKGROUND OF THE INVENTION:

This invention relates generally to structural fasteners, and more particularly relates to a structural fastener having a swage collar and an internal seal
10 to prevent leakage through a connection fastened by the structural fastener.

Structural fasteners of the type to which this invention is directed typically include a headed pin with locking grooves, and a generally cylindrical collar for the pin. The structural fastener is typically used to secure a composite assembly of workpieces, and the pin is placed in aligned apertures through the workpieces to be
15 secured together, and the collar is placed over the locking grooves of the pin. The collar is then radially compressed into the locking grooves to affix the collar on the pin. A tool that is commonly used to compress the collar over the locking grooves of the pin is a swaging tool which pulls the pin in one direction and forces a swage anvil over the collar in the other direction to affix the collar to the pin and forcibly clinch
20 the workpieces together. When such structural fasteners are used in applications such as the joining of parts to liquid containing tanks such as aircraft fuel tanks, it is desirable that leakage from such tanks not be allowed to occur around or through such fasteners. The present invention meets these and other needs.

25

SUMMARY OF THE INVENTION

Briefly, and in general terms, the present invention provides for a

structural fastener having a swage collar and an internal sealing insert to prevent leakage through a connection fastened by the structural fastener. The invention accordingly provides for a swage collar apparatus for sealing a connection of a fastener through a composite assembly of workpieces to be secured together, and for preventing leakage through the connection. The fastener typically includes a shaft having an externally threaded or grooved section. In a presently preferred embodiment, the swage collar apparatus includes a swage collar adapted to be disposed over the threaded or grooved section of the fastener, and an internal sealing insert disposed in the swage collar over the fastener.

10 The swage collar preferably comprises a hollow, generally cylindrical collar, having a main body portion with a main central bore, and a base portion with an internal shoulder formed in the main central bore so as to form a seal receiving guide, the internal shoulder having a diameter that is larger than the diameter of the main central bore. In a preferred aspect, the base portion is flared outward, having an external diameter larger than the main central bore. The swage collar is preferably formed of a deformable material, which may be a deformable metal such as aluminum or titanium, for example. In a presently preferred embodiment, the internal sealing insert is made of tetrafluoroethylene.

20 In one presently preferred embodiment, the shaft includes an unthreaded section, and the internal sealing insert interfaces with the threaded section and the unthreaded section of the shaft of the pin. In an alternate embodiment, the internal sealing insert interfaces with the unthreaded section of shaft of the pin.

25 In another aspect, the invention also provides for a method of installing a sealing fastener, in which the swage collar and sealing insert form a swage collar assembly that is fitted over the fastener, and a swaging tool is fitted over the swage collar assembly. The swaging tool has a collar entrance aperture at one end with an inside diameter at an inside edge that is slightly larger than the outside diameter of the swaging collar at the outside edge of the swaging collar, so as to fit over the swaging collar. The swaging tool is forced over the swage collar assembly with sufficient force

to cause plastic deformation in the swaging collar so that the material of the swaging collar is forced into engagement with the shaft of the fastener, and to bring the internal sealing element into sealing engagement with the shaft of the fastener to form a fluid impermeable seal to prevent leakage through a connection formed by the fastener
5 through the composite assembly of workpieces.

In another aspect, the invention provides for a swage fastening system, including a pin having an enlarged head, a smooth neck, and a threaded body, a generally cylindrical collar, and a sealing ring. The collar preferably has a main central bore, and a base portion with an internal shoulder formed in the main central
10 bore so as to form a seal receiving guide. The internal shoulder has a diameter that is larger than the diameter of the threaded body, and the sealing ring is disposed within the internal shoulder and adapted to receive the pin. A swage tool is also provided which mechanically forces the collar over the pin affixing a workpiece between the enlarged head and the collar with the sealing ring deforming and forming a fluid
15 impermeable seal.

These and other aspects and advantages of the invention will become apparent from the following detailed description and the accompanying drawings, which illustrate by way of example the features of the invention.

20 BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a sectional view of an assembly according to a first preferred embodiment, showing a portion of a pin with the swaging collar and internal sealing insert, according to the present invention;

25 Figure 2 is a sectional view of an assembly according to a second preferred embodiment, showing a portion of a pin with the swaging collar and internal sealing insert, according to the present invention;

Figure 3 is a sectional view of a swaging collar and a sealing insert in an uninstalled and unswaged condition apart from the pin, according to the present

invention;

Figure 4A is a perspective view of a swaging tool according to the present invention;

Figure 4B is a plan view of the swaging tool of Figure 4A;

5 Figure 4C is a sectional view of the swaging tool taken along line 4C-4C of Figure 4B;

Figure 4D is a sectional view of an alternate embodiment of a swaging tool according to the present invention;

Figure 4E is an end view of the swaging tool of Figures 4A and 4D;

10 Figure 5A is a schematic diagram showing the slicing off of a portion of a metal wire or bar stock to form a blank for the formation of the swaging collar, according to the present invention;

Figure 5B is a schematic diagram illustrating the punching of the blank of Figure 5A for form indentations in the blank;

15 Figure 5C is a schematic diagram illustrating the forcing of the punched blank into a die by another punch to form the swaging collar according to the present invention;

Figure 6A is a sectional view of a swaging collar and a sealing insert assembly showing the dimensions of the sealing insert in relation to the collar;

20 Figure 6B is a sectional view of a swaging collar showing the dimensions of the collar;

Figure 6C is a sectional view of an alternate embodiment of a blank for the formation of the swaging collar;

25 Figure 7A is a partially exploded perspective view of a swaging tool assembly;

Figure 7B is a perspective view of the assembled swaging tool of Figure 7A;

Figure 7C is an end view of the assembled swaging tool of Figure 7B;

Figure 7D is a sectional view of the swaging tool assembly taken along

line 7D-7D of Figure 7C;

Figure 8 is a sectional view of an alternate embodiment of a swaging collar and a sealing insert in an uninstalled and unswaged condition apart from the pin, according to the present invention; and

5 Figure 9 is a detail view of the circled portion of Figure 8.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention is depicted in cross-section in Figures 1 and 2. A
10 preferred embodiment of the invention includes a hollow, generally cylindrical swage or swaging collar 3 with an internal sealing insert 5. The swaging collar includes a main body portion 1 with a main central bore 2, and a base portion 4 with an internal shoulder 6 formed in the main central bore so as to form a seal receiving guide. The
15 internal shoulder has a diameter that is larger than the diameter of the main central bore. The base portion is preferably flared outward, and has an external diameter larger than the main body portion. The swage collar and seal are intended for use with an externally threaded fastener such as a pin 7 having a shaft 8 and an enlarged head 9, the pin being of the type used in fastening together components 11 in aerospace and
other applications.

20 Figure 1 depicts an assembly in which the relative dimensions of the pin 7, its threads or grooves 10, the swage or swaging collar 3, and the internal sealing insert 5 are such that the sealing insert interfaces with a relatively flat, unthreaded, ungrooved section 12 of the pin. Figure 2 depicts an assembly in which the relative
25 dimensions of the pin 7, its threads or grooves 10, the swaging collar 3, and the internal sealing insert 5 are such that the sealing insert interfaces with a threaded or grooved section 15 of the pin. Although either configuration may provide a useful fastener, the configuration of Figure 2 provides greater grip and more secure sealing and is therefore regarded as preferable.

Figure 3 depicts a swaging collar 3 and a sealing insert 5 in an

uninstalled and unswaged condition apart from the pin (not shown). The collar is made of a suitable metal or another deformable material. Applicants have used aluminum (2024 Aluminum per QQ-A-430 or AMS-QQ-225/6), with heat treatment to a T4 or T42 condition per AMS2770 or AMS-H-6088), and commercially pure titanium (CP Titanium per ASTM B348 Grade 1, MIL-T-9047 CP-4). Applicants have used tetrafluoroethylene (TFE), such as TFE available under the brand name "TEFLON" from DuPont, per ASTM D1710 Type I, Grade 1 for the sealing insert. Other materials may be specified for either the collar 3 or the sealing insert 5 based on desired material properties well known to those skilled in the art. Exemplary dimensions for the swaging collar and sealing insert as depicted in Figure 3 are presented in Table 1 below. In the tables below, "Dash No." indicates the nominal diameter of a mating pin in 1/32nds of an inch. The dimensions apply after the swaging collar and sealing insert are finished, and in Figure 3, the diameter "C" is the inner diameter of the sealing insert.

Dash No.	Pin Nom. Dia.	A Dia.	B Dia.	C Dia. Min.	E Dia. Min.	F Dia.	J RAD REF.	L	M Max.	N REF.	P Max
6	3/16	.384 .364	.193 .189	.188	.185	.298 .294	.150	.284 .264	.055	.060	.016
8	1/4	.477 .457	.253 .249	.248	.245	.391 .387	.150	.349 .329	.070	.060	.016
10	5/16	.581 .561	.316 .312	.310	.310	.484 .480	TBD	.448 .428	TBD	.060	.031
12	3/8	.712 .692	.378 .374	.372	.372	.588 .584	TBD	.493 .473	TBD	.060	.031

Table 1. Dimensions of the swaging collar and sealing insert

The collar assembly 18, comprising the swaging collar 3 and the sealing insert 5 illustrated in Figure 3, is installed using a swaging tool 20 depicted in Figures 4A-4E. Note that the dimensions given for the swaging tool depicted in Figure 4A-4E are not consistent with use with the collar assembly 18 depicted in Figure 3. As noted above, the collar assembly may have a wide range of dimensions. Each collar assembly will be installed with an appropriately sized matching swaging tool.

Referring now especially to the cross-sectional detail view of Figure 4C, the swaging tool 20 defines a collar entrance aperture 23 at one end. A transverse aperture 24 is provided through the body of the swaging tool for a dowel pin 26 shown in Figure 7A. The tool is sized so that the entrance aperture has an inside diameter at its edge 25 that is slightly larger than the outside diameter of the swaging collar at the swaging collar's outside edge 27 (see, e.g. Figure 3). The swaging tool may thus be fit over the swaging collar. The interior 30 of the swaging tool necks down smoothly to a relatively narrow point 32 on the swaging tool where the inside diameter is slightly smaller than the outside.

To swage the collar assembly 18 onto a threaded pin 7, the collar assembly is first fitted over the pin. The relative clearances between the pin and the sealing element and swaging collar are such that this may be done by an assembler by

hand. The swaging tool 20 is then fit over the swaging collar and forced over the collar by a pneumatic impact tool or another appropriate means. Sufficient force is applied to the swaging collar to cause plastic deformation in the swaging collar so that the material of the swaging collar is force into the threads, thereby bringing the sealing
5 element into tight sealing engagement with the pin as shown, e.g., in Figures 1 and 2.

A swaging collar assembly incorporating the invention has been found to be particularly useful in applications such as the joining of parts to aircraft fuel tanks. The combination of the threaded pin and metal swaging collar provide an inexpensive, easily installed, and secure fastener for joining the parts together, while
10 the presence of the sealing element and its engagement with the pin prevent leakage of fuel or other fluids from the tank.

The swaging collar may be formed by conventional machining technique such as turning on a lathe. It has been found more economical, though, to form the swaging collar 3 by a technique illustrated in Figures 5A-5C. As indicated in Figure
15 5A, the process begins with a length of metal wire or bar stock 35. A forming blank 38, having a volume equal to the final volume of the swaging collar, is sliced off the end of the stock.

Moving now to Figure 5B, the forming blank 38 is punched at both ends to form twin indentations 40 in the cylindrical blank. Finally, as indicated in Figure
20 5C, the punched blank 43 is forced into a die 45 by another punch 47. The punch goes entirely through the blank, forming an opening through it while forcing it against the sides of the die. A step 50 on the punch forms a well 52 (see Figure 3), into which the sealing insert 5 is set before the collar assembly 18 is swaged onto the pin.

Figures 6A-B show views and dimensions of a collar and insert assembly
25 with exemplary dimensions presented in Table 2 below. Figure 6C shows an alternate embodiment of a preform blank 43' of the collar with the blank formed with an opening entirely through the blank, for dash no. sizes 10 and 12, with exemplary dimensions presented in Table 3 below. Figures 7A-D show views of a swaging tool assembly 60, which includes an anvil 62, ball bearings 64 at a top end 65 of the anvil,

a nut 66 over the ball bearings at the top end of the anvil, and over a snap ring 68 located in a groove 70 at a mid-portion of the anvil. A sleeve 72 is provided over and threadedly connected to the nut, extending to the bottom end 73 of the anvil.

5	Dash No.	A Dia.	B Dia.	E Dia. Min	F Dia.	H Dia.	J Rad	L	N	P Max	X	AB Dia. Min.	AD
	5	.346 .326	†	.160	.260 .256	.167 .163	†	.266 .246	.065 .055	.016	.060 .055	.164	†
	6	.384 .364	†	.185	.298 .294	.193 .189	†	.284 .264	.065 .055	.016	.060 .055	.188	†
	8	.477 .457	.325 .323	.245	.391 .387	.253 .249	.160 .150	.349 .329	.060 .055	.016	.060 .055	.248	.055 .040
10	10	.581 .561	†	.310	.484 .480	.316 .312	†	.448 .428	.060 .055	.031	.060 .055	.310	†
	12	.712 .692	†	.372	.588 .584	.378 .374	†	.493 .473	.060 .055	.031	.060 .055	.372	†

Table 2. Dimensions of the swaging collar and sealing insert (†- To be determined)

15

Dash No.	BA Dia.	BH Dia.	BL	BR Rad.
10	.569 .567	.320 .318	TBD	.040 .030
12	.700 .698	.382 .380	TBD	.040 .030

20

Table 3. Dimensions of the preform blank

Figures 8 and 9 depict an alternate embodiment of a swaging collar 83 and a sealing insert or sealing ring 85 in an uninstalled and unswaged condition apart from the pin (not shown). The swaging collar includes a main body portion 81 with a main central bore 82, and a base portion 84 with an internal shoulder 86 formed in the main central bore so as to form a seal receiving guide. The internal shoulder has

an interior diameter that is larger than the diameter of the main central bore. The base portion is preferably flared outward, and has an external diameter larger than the main body portion. The swage collar and seal are intended for use with an externally threaded or grooved fastener such as a pin having a shaft and an enlarged head, the pin being of the type used in fastening together components in aerospace and other applications, as described above. The collar is made of a suitable metal or another deformable material, such as commercially pure titanium or aluminum, as described above. The sealing insert may also be made of tetrafluoroethylene (TFE), such as TFE available under the brand name "TEFLON" from DuPont, as described above.

Other materials may be specified for either the collar 83 or the sealing insert 85 based on desired material properties well known to those skilled in the art. The sealing insert includes an annular rounded exterior flange 87, that interfits into a corresponding rounded channel or groove 89 in the internal shoulder of the main central bore, in order to lock the sealing insert into place within the internal shoulder portion of the main central bore. The internal shoulder of the main central bore may also include an intermediate stepped portion 90 with an interior diameter that is less than the interior diameter of the internal shoulder 86 and greater than the diameter of the main central bore, in order to further lock the sealing insert into place in the internal shoulder of the main central bore.

It will be apparent from the foregoing that while particular forms of the invention have been illustrated and described, various modifications can be made without departing from the spirit and scope of the invention. Accordingly, it is not intended that the invention be limited, except as by the appended claims.

WHAT IS CLAIMED IS:

1. A swage collar apparatus for sealing a connection of a fastener through a composite assembly of workpieces together and for preventing leakage through the connection, the fastener including a shaft having an externally threaded or grooved section, the swage collar apparatus comprising:
 - 5 a swage collar adapted to be disposed over the shaft of the fastener; and
 - an internal sealing insert disposed in the swage collar over the fastener.
2. The swage collar apparatus of Claim 1, wherein the swage collar comprises a hollow, generally cylindrical collar, having a main body portion with a main central bore, and a base portion with an internal shoulder formed in the main central bore so as to form a seal receiving guide, the internal shoulder having a diameter that is larger than the diameter of the main central bore.
3. The swage collar apparatus of Claim 2, wherein the base portion is flared outward, having an external diameter larger than the main central bore.
4. The swage collar apparatus of Claim 1, wherein the swage collar is made of a metal.
5. The swage collar apparatus of Claim 4, wherein the swage collar is made of aluminum.
6. The swage collar apparatus of Claim 4, wherein the swage collar is made of titanium.
7. The swage collar apparatus of Claim 1, wherein the swage collar is made of a deformable material.

8. The swage collar apparatus of Claim 1, wherein the internal sealing insert is made of tetrafluoroethylene.

9. The swage collar apparatus of Claim 1, wherein the shaft includes an unthreaded section, and the internal sealing insert interfaces with the unthreaded section of shaft of the pin.

10. The swage collar apparatus of Claim 1, wherein the shaft includes a threaded section and an unthreaded section, and the internal sealing insert interfaces with the threaded section and the unthreaded section of the shaft of the pin.

11. The swage collar apparatus of Claim 2, wherein the internal sealing insert has a surface defining an annular rounded exterior flange, and the internal shoulder of the main central bore has a surface defining a corresponding rounded channel or groove into which the annular rounded exterior flange interfits, to thereby
5 lock the internal sealing insert into place within the internal shoulder portion of the main central bore.

12. The swage collar apparatus of Claim 11, wherein the internal shoulder of the main central bore includes an intermediate stepped portion having an interior diameter that is less than the interior diameter of the internal shoulder and greater than the diameter of the main central bore.

13. A sealing fastener apparatus for joining a composite assembly of workpieces together and for preventing leakage through a connection formed by the fastener through the composite assembly of workpieces, comprising:

a fastener having a shaft;

5 hollow, generally cylindrical swage collar, the swage collar having a main body portion with a main central bore adapted to be disposed over at least a

portion of the fastener; and

an internal sealing insert disposed in the swage collar about the fastener.

14. The sealing fastener apparatus of Claim 13, wherein the fastener comprises a pin having a head and a shaft, the shaft having an externally threaded section and an unthreaded section.

15. The sealing fastener apparatus of Claim 13, wherein the swage collar includes a base portion with an internal shoulder formed in the main central bore so as to form a seal receiving guide, the internal shoulder having a diameter that is larger than the diameter of the main central bore.

16. The sealing fastener apparatus of Claim 13, wherein the base portion is flared outward, having an external diameter larger than the main central bore.

17. The swage collar apparatus of Claim 13, wherein the swage collar is made of a metal.

18. The swage collar apparatus of Claim 17, wherein the swage collar is made of aluminum.

19. The swage collar apparatus of Claim 17, wherein the swage collar is made of titanium.

20. The swage collar apparatus of Claim 13, wherein the swage collar is made of a deformable material.

21. The swage collar apparatus of Claim 13, wherein the internal sealing insert is made of tetrafluoroethylene.

22. The swage collar apparatus of Claim 14, wherein the internal sealing insert interfaces with the unthreaded section of shaft of the pin.

23. The swage collar apparatus of Claim 14, wherein the internal sealing insert interfaces with the threaded section and the unthreaded section of the shaft of the pin.

24. The swage collar apparatus of Claim 15, wherein the internal sealing insert has a surface defining an annular rounded exterior flange, and the internal shoulder of the main central bore has a surface defining a corresponding rounded channel or groove into which the annular rounded exterior flange interfits, in order to lock the internal sealing insert into place within the internal shoulder portion of the main central bore.

25. The swage collar apparatus of Claim 24, wherein the internal shoulder of the main central bore includes an intermediate stepped portion having an interior diameter that is less than the interior diameter of the internal shoulder and greater than the diameter of the main central bore.

26. A method of installing a sealing fastener, the sealing fastener including a fastener having a shaft, a swaging collar, and an internal sealing insert, the swaging collar and internal sealing insert forming a swage collar assembly, the swaging collar having an internal bore and adapted to be disposed over the shaft of the fastener, and the internal sealing insert disposed within at least a portion of the internal bore of the swaging collar, comprising:

fitting the swage collar assembly over the fastener;

fitting a swaging tool over the swage collar assembly, the swaging tool having a collar entrance aperture at one end, the collar entrance aperture having an inside diameter at an inside edge that is slightly larger than the outside diameter of the

swaging collar at the outside edge of the swaging collar, so as to fit over the swaging collar; and

forcing the swaging tool over the swage collar assembly with sufficient force to cause plastic deformation in the swaging collar so that the material of the swaging collar is forced into engagement with the shaft of the fastener, and to bring the internal sealing element into sealing engagement with the shaft of the fastener to form a fluid impermeable seal to prevent leakage through a connection formed by the fastener through the composite assembly of workpieces.

27. A swage fastening system, comprising:

a pin, the pin having an enlarged head, a smooth neck, and a threaded body;

a generally cylindrical collar, the collar having a main central bore, a base portion with an internal shoulder formed in the main central bore so as to form a seal receiving guide, the internal shoulder having a diameter that is larger than the diameter of the threaded body;

a sealing ring disposed within the internal shoulder and adapted to receive the pin; and

a swage tool which mechanically forces the collar over the pin affixing a workpiece between the enlarged head and the collar with the sealing ring deforming and forming a fluid impermeable seal.

28. The swage fastening system of Claim 27, wherein the collar is made of a metal.

29. The swage fastening system of Claim 28, wherein the swage collar is made of aluminum.

30. The swage fastening system of Claim 28, wherein the swage collar

is made of titanium.

31. The swage fastening system of Claim 27, wherein the swage collar is made of a deformable material.

32. The swage fastening system of Claim 27, wherein the sealing ring is made of tetrafluoroethylene.

33. The swage fastening system of Claim 27, wherein the pin includes an unthreaded section, and the sealing ring interfaces with the unthreaded section of the pin.

34. The swage fastening system of Claim 27, wherein the pin includes an unthreaded section, and the sealing ring interfaces with the threaded body and the unthreaded section of the pin.

35. The swage fastening system of Claim 27, wherein the sealing ring is formed of tetrafluoroethylene.

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FIG. 1

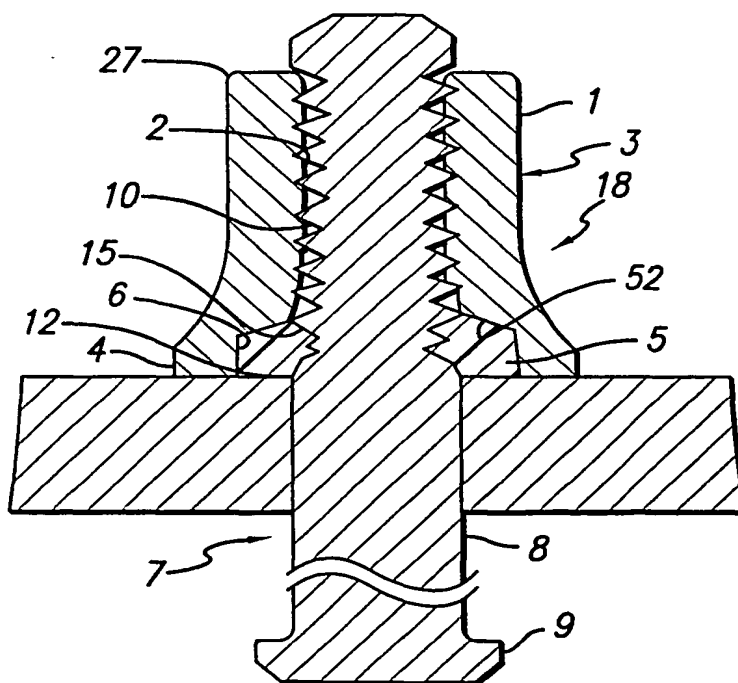
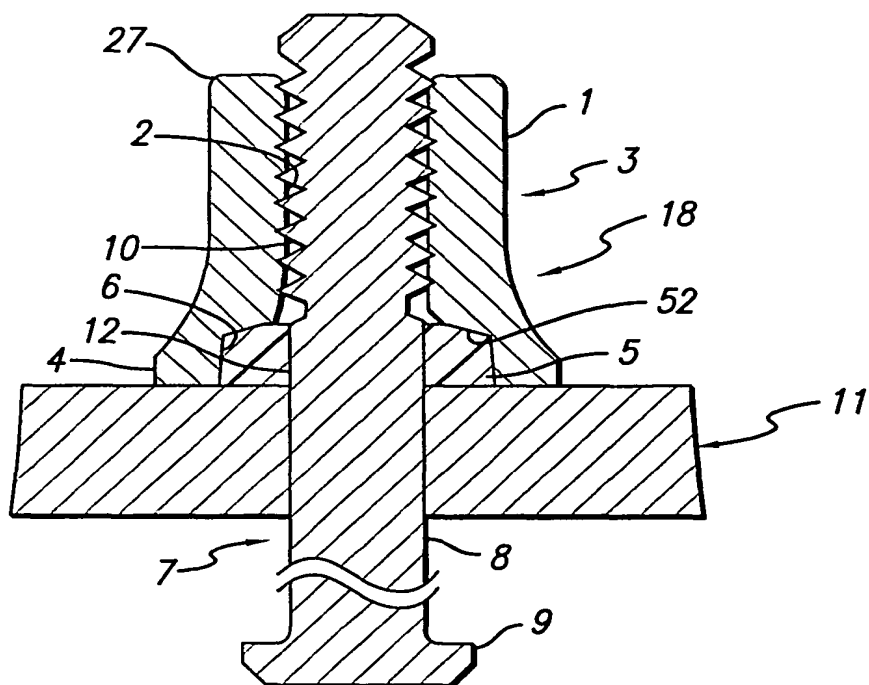


FIG. 2

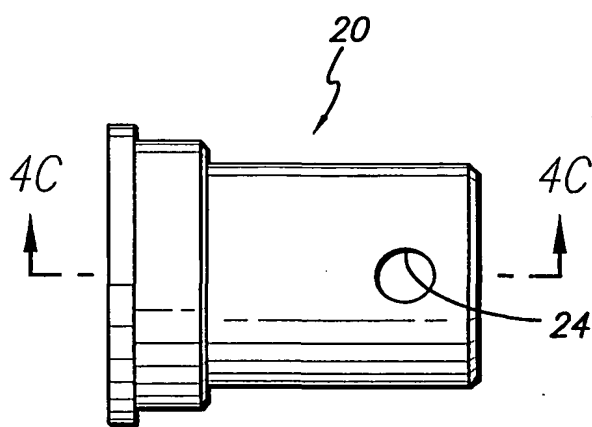


FIG. 4B

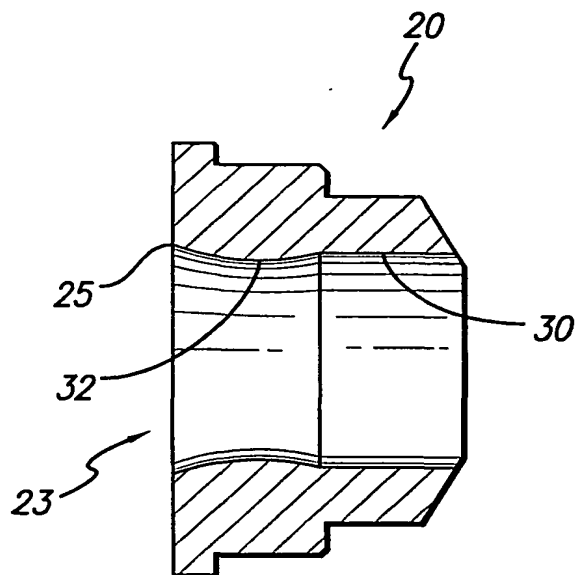


FIG. 4D

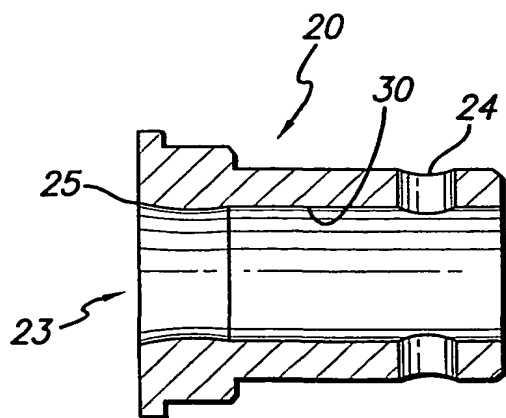


FIG. 4C

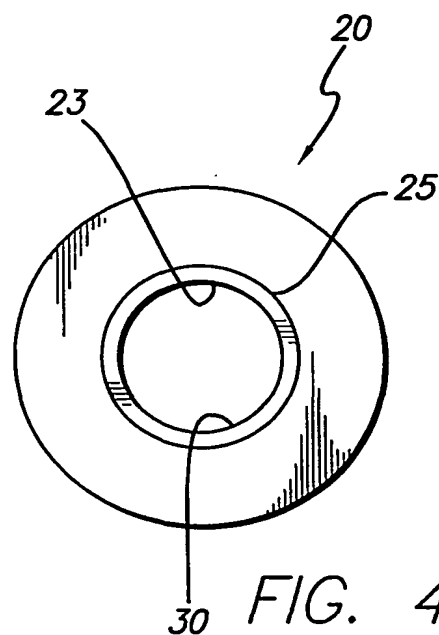


FIG. 4E

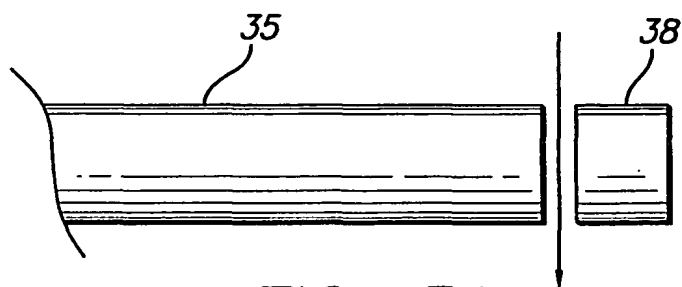


FIG. 5A

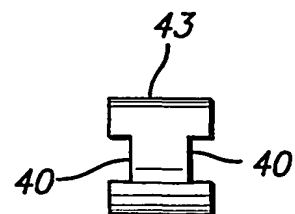


FIG. 5B

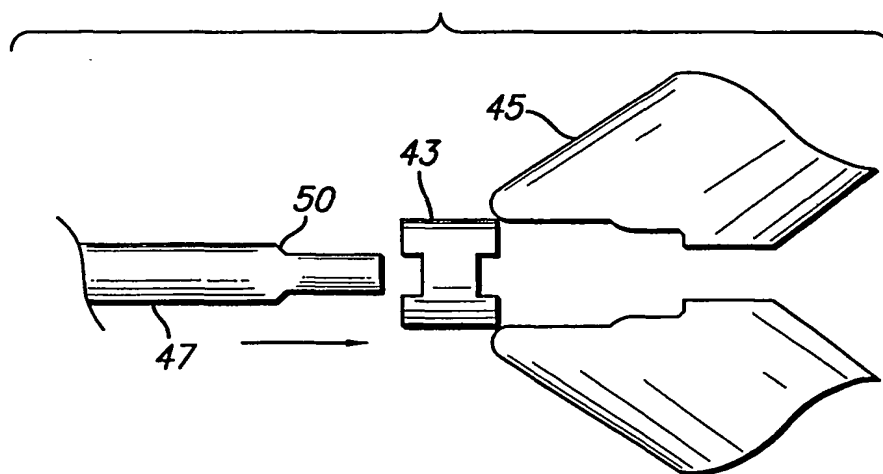


FIG. 5C

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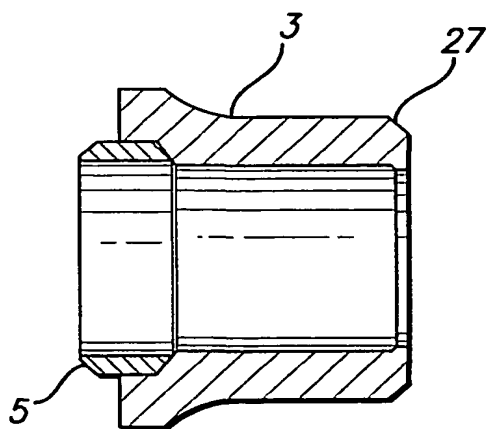


FIG. 6A

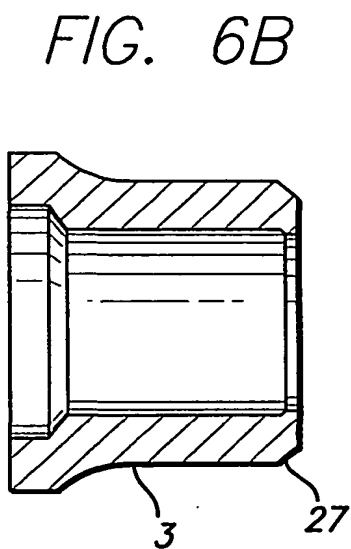


FIG. 6B

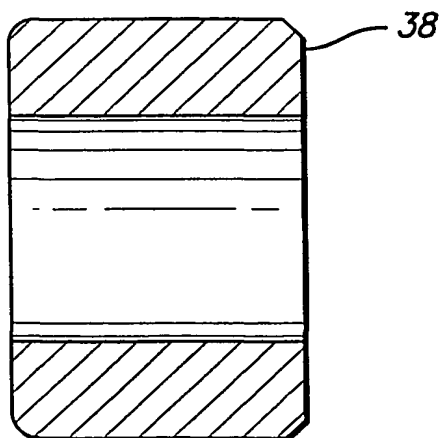


FIG. 6C

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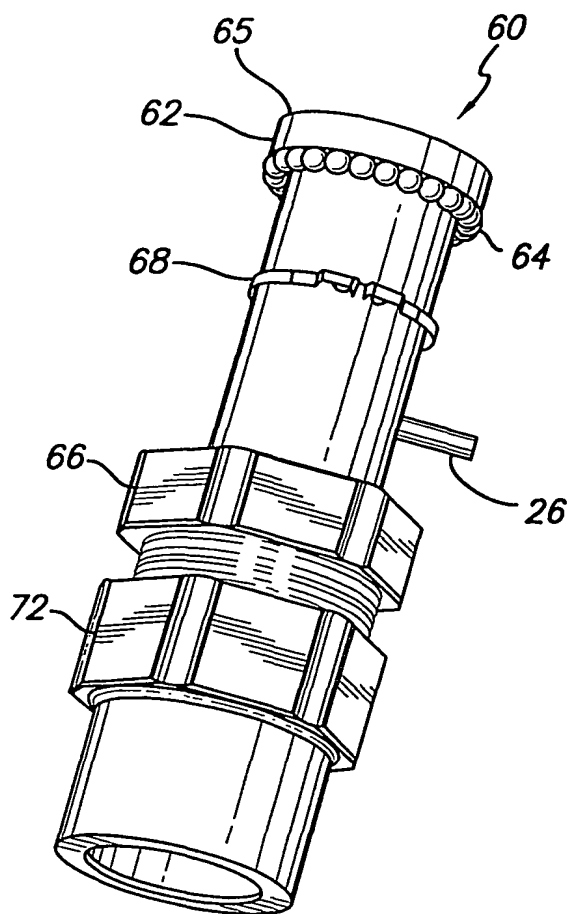


FIG. 7A

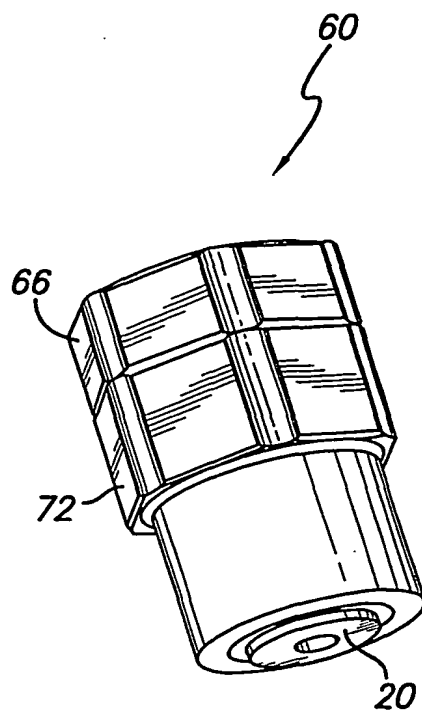


FIG. 7B

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FIG. 7C

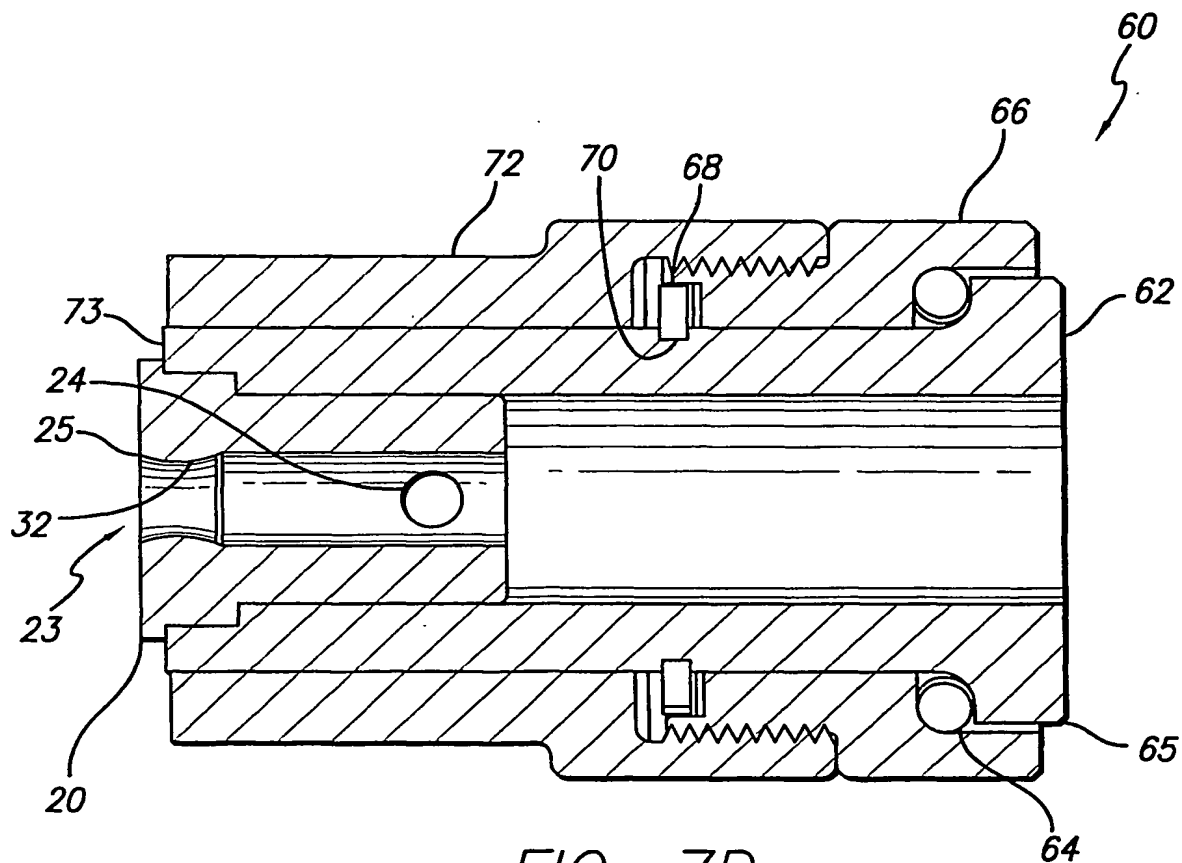
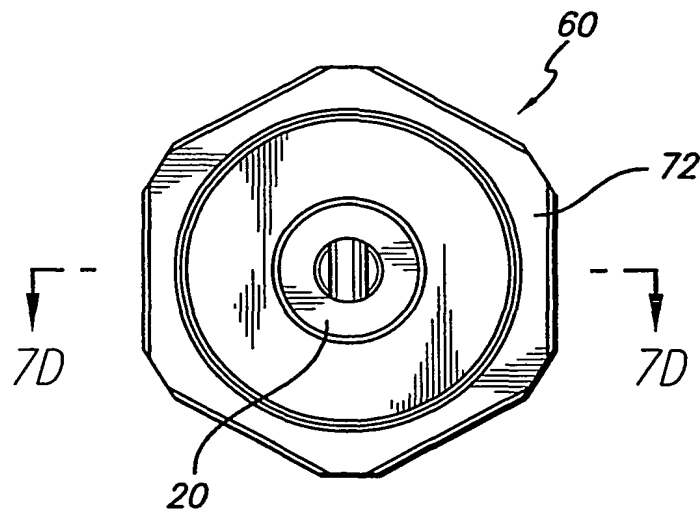


FIG. 7D

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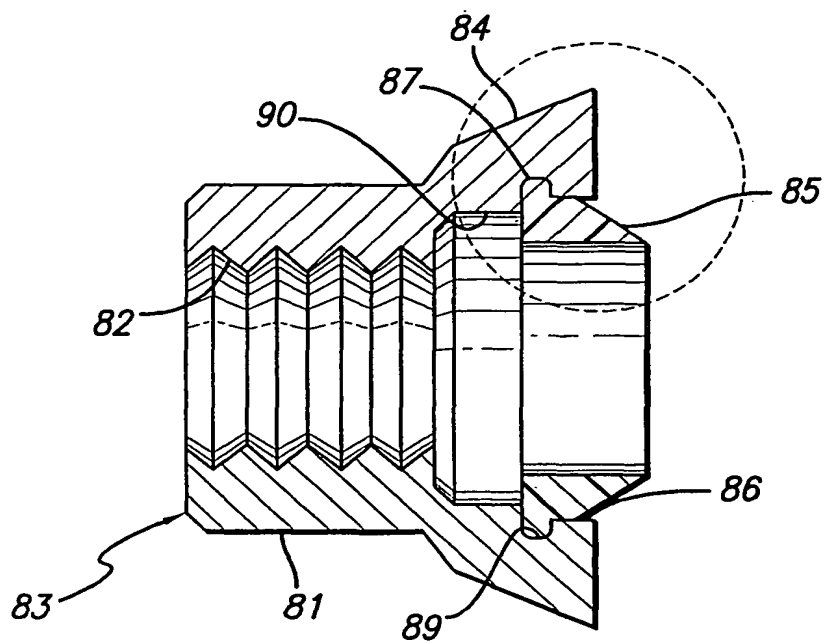


FIG. 8

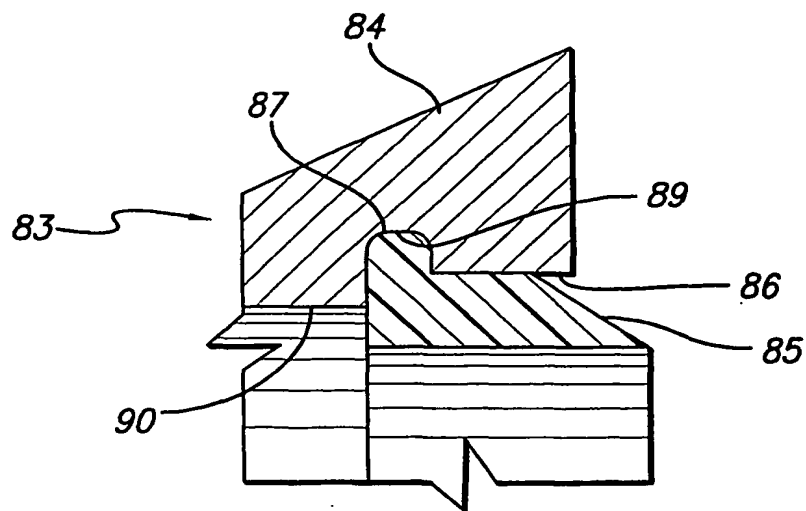


FIG. 9

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/19983

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 F16B19/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 F16B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 094 017 A (GEORGE SIEBOL ET AL) 18 June 1963 (1963-06-18) abstract column 1, line 34 - line 49 column 3, line 23 - line 38 figures 5,9,10	1-7, 12-20, 26-31
A	US 5 562 379 A (RAUSCH JAMES G ET AL) 8 October 1996 (1996-10-08) abstract figures 4,6,7 --- -/--	1-4, 10-17, 26-28

☒ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

12 November 2001

Date of mailing of the international search report

21/11/2001

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INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/19983

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 119 467 A (HI SHEAR CORP) 16 November 1983 (1983-11-16) abstract figure 1 ----	1-4, 10-17, 26-28
A	US 3 464 472 A (REYNOLDS PERRY J) 2 September 1969 (1969-09-02) column 1, line 28 - line 60 -----	1,13,21, 26,35

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. Application No
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US 5562379	A	08-10-1996	NONE	
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